

AMENDMENTS TO THE SPECIFICATION:

Please amend the paragraph beginning at page 2, line 13, as follows:

There are two primary reasons for this. These can be seen by first considering an array made up of N individual antenna elements. The overall array gain, G(2), for this N-element system in the direction θ when each element is uniformly illuminated, can be written (in dBi) as,

$$G(\theta) = 10 \log(N) + g(\theta) + 10 \log(1 - |\Gamma(\theta)|^2) - \alpha \quad (1)$$

where $g(\theta)$ is the embedded gain pattern for an individual antenna element in the direction θ , $\Gamma(\theta)$ is the active reflection coefficient, and α represents losses in the beam forming network that are independent of $\Gamma(\theta)$. Equation (1) presumes the array is being steered in the θ direction. Thus, the expression does not represent the array pattern but, rather, it represents the gain in the scan direction. In particular $\Gamma(\theta)$ is the effective reflection coefficient when the individual array elements are phased so as to produce a beam in the θ direction. Also $g(\theta)$ and $\Gamma(\theta)$ are assumed to be the same for all of the N elements. This latter assumption is an approximation. In practice there will be element-to-element differences. Indeed, for applications involving moderate sized arrays the element-to-element variations in $g(\theta)$ may have significant impacts on the array performance.

Please amend the paragraph beginning at page 3, line 14, as follows:

In other words, the embedded element gain characteristics as a function of angle and frequency ~~is a~~are fundamental limits in the range of angles the array can be scanned to and the frequencies at which it will operate.

Please amend the paragraph beginning at page 7, line 14, as follows:

Figure 5 illustrates a simplified phased array concept made up of parasitically controlled elements all controlled ~~from~~from a single beamforming control unit and corporate fed into a transmit/receive module (which can also represent a single subarray for a larger array);

Please amend the paragraph beginning at page 9, line 18, as follows:

Figure 1 shows a schematic representation of a single-element controlled parasitic antenna (CPA). The CPA (as taught in parent application 10/206,101) makes use of a feedback loop to adaptively determine the value of the control signal that will control the parasitic control device placed in or near to the parasitic control element in the aperture of the antenna. This feedback loop contains a controller which has an adaptive logic unit, a control signal circuit, and the control device. The control device can be either a two state switch, which usually manifests itself as a two-state reactance, or it can be a continuously variable device (or multiple devices) such as a variable capacitor or varactor used by itself or as part of a control circuit. The feedback loop can tap the output either before (pre) or after (post) the receiver.

Please amend the paragraph beginning at page 11, line 10, as follows:

Figure 4 shows a phased array configuration made up of N single-element controlled parasitic antennas. In this configuration, there would be a central beamforming control unit to control the steering (i.e., the pointing angle) of the array by controlling the phase of each element as well as controlling the gain pattern of each of the N individual antenna elements via the parasitic controller. The individual elements can have the local feedback control as shown in **Figure 3**. The Beamforming Control Unit controls not only the phase of each individual element but it also can control the loading of the parasitic elements associated with each element in the array. This same control can also be used to adjust the magnitude of each element by way of the parasitic control element.

Please amend the paragraph beginning at page 12, line 5, as follows:

In **Figure 6** the beamforming for the array is represented as either being done using true-time delay or done via digital beamforming. In either case, each subarray can still be parasitically controlled to shift the individual element's gain pattern or to retune the antenna element. **Figure 7** presents an alternative depiction of the reconfigurable subarray concept.

Please amend the paragraph beginning at page 13, line 11, as follows:

The measurements shown in **Figure 11** were performed on the 3-element array of loaded parasitic elements shown in **Figure 10**. The figure is actually a picture of the network analyzer screen, which shows the measured reflection coefficient (return loss) at the center element port for both the shorted (yellow arrow-marked curve) and open (green unmarked curve) states of the elements. The frequency scale is 4 to 9 GHz in steps of 0.5 GHz. For the shorted state the antenna has its best tuning at 5.6 GHz and the open state is best tuned at 6.2 GHz. The reconfiguration of the element has clearly changed the tuning characteristics. However, there is still a common tuned band for both states, which approximately spans the 5 to 6 GHz range. **Figure 12** shows corresponding computed results for this case. There is a good comparison between the measured and modeled results.

Please amend the paragraph beginning at page 14, line 13, as follows:

We performed a limited study to test the concept of switching the state of an element to alter its properties. The eventual goal would be to optimally design such elements in a manner that is favorable to the design of a phased array with substantially broader coverage than would otherwise be possible without the element reconfiguration. This test was limited in scope and focused primarily on laboratory demonstration and experimentation. Active switch devices and biases were not used, as would be the case in an actual application. Instead we built elements and

arrays that could be manually switched between two different configurations. This manual switching was accomplished by using silver paint to short an otherwise open end of the element to the ground plane. The paint could be easily removed to restore the 'open state' of the antenna element or array of elements. These two configurations simulated two different element states that could be achieved by using an electronic switch. The properties of the elements were measured and/or computed for both states. In most cases we were able to make good comparisons between measurements and predictions. The results are encouraging and show that both the both the embedded patterns and active return loss can be significantly controlled using reconfigurable parasitic elements within the phased array.

Please amend the paragraph beginning at page 15, line 10, as follows:

The element shown above has two parts. One is an active 'arm' ~~(green)~~ that connects to the feed port, which is basically a via through the ground plane. On either side of the active arm is a parasitic loop. Each end of one of these loops terminates at a port, which is also a via through the ground plane. Impedances can be applied at these latter ports. These load impedances affect the antenna characteristics of the element. Even though there are 4 load ports there were only two independent load values for the examples that are shown in this section. These are indicated in the above figure. For the studies to be shown these impedances were chosen to maximize the V-pol gain for various scan angles at 10.5 GHz.

Please amend the paragraph beginning at page 16, line 14, as follows:

A reconfigurable array element that is a variation of the element shown in **Figure 14** is shown in **Figure 21**. This element consists of two active arms of the **Figure 14** element. These active arms are orthogonal. Parasitic elements of the same size as the ones in **Figure 14** are also shown. For this element these ~~parasities~~parasitic elements are orthogonal. Each element has two

feed ports and four load ports. For the study shown in this section the feed ports were combined using a pair of switches and a phase shifter. This enables control over the polarization of the element. For the element shown above the active 'arms' (green) connect to the feed ports. On either side of each active arm is a parasitic loop. Each end of one of these loops terminates at a port, which is a via through the ground plane. Impedances can be applied at these latter ports. These load impedances affect the antenna characteristics of the element. In this case all four load ports were allowed to have independent load values. These are indicated in the above figure. For the studies to be shown these impedances were chosen to maximize the total gain for various scan angles at 10.5 GHz. Note that this element allows for both V-pol and H-pol as well as combinations of these two basic polarizations.

Please amend the paragraph beginning at page 17, line 14, as follows:

~~In~~ **Figure 23** shows the main-beam patterns for the various scan angles that were used. These results should be compared with **Figure 16**, which shows the beam patterns of the 16 element array from the previous section. The dual polarized element shows enhanced gain at all scan angles when compared to the previous results. The polarization of the element varies from scan to scan. Gain depression is still noted near the end-fire direction but the magnitude of this depression is not as great as before. It also appears that the gain is somewhat better for the opposite end-fire direction when compared with **Figure 16**. This indicates that the dual polarized element should be oriented in the opposite direction to what is shown in **Figure 21**.

Please amend the paragraph beginning at page 18, line 1, as follows:

It was mentioned above that the switch values were variables in the optimization for each scan direction. In most cases the optimization procedure chose both switches to be on with some relative phase between the V-pol and H-pol feeds. The beams for these scans are ~~red~~solid in

Figure 1623. However, in a few cases the optimizer "turned off" the V-pol feed in favor of the H-pol feed. These are shown as ~~blue~~dashed bold lines in the figure. It is interesting to note that these correspond to the directions where the gain depression tends to occur. The gains for these beams have a dominant H-pol component. This indicates that the gain depression problem is related not only to the scan angle but also the polarization of the elements. It appears that elements with variable polarization may provide a means of mitigating gain depression.